Design Guidelines for Mirror Support Systems in Large Lasers*

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Guidelines for the design of mirror support systems in large laser systems are summarized, based on the experience of designing similar systems at LLNL. A mirror system consists of a mirror, mirror mount, mirror mount enclosure, and mirror support structure. The stability requirements for the mirror must be determined to satisfy overall system pointing requirements. These include allowable translation and rotation motion over a given time period. Calculation of motion can be performed as a result of random vibration excitation, acoustic inputs, thermal distortion (both locally and globally), and other effects using analytical techniques. With a temperature stabilized room, random vibration is usually the predominant motion. The system needs to be designed so that random vibration excitation of the facility is minimized, as well as the motion of the mirror due to amplification of the noise through the structure. Input excitation level is dependent on the site and facility design, which can be reduced by careful consideration of facility location and noise sources. NIF is being designed assuming a random vibration excitation PSD of $1\text{x}10^{-10}$ g^2/Hz from 1 to 200 Hz. This is consistent with data from existing ICF facilities at LLNL such as Nova and Beamlet. Flexibility of the floor must be considered when calculating motion of large structures. This can reduce the calculated fundamental frequency of a structure on a rigid foundation by a significant fraction (1/3). Reducing amplification of noise from the floor to the mirror traditionally requires stiff components in both the mirror mount and mirror support structure. These typically have disparate fundamental frequencies of vibration, with a resulting response that is dominated by the structure (lowest frequency). The support structure is often fabricated of steel, which is inexpensive and can have a fundamental frequency above 15 Hz, but has low modal damping at random vibration levels. Recent designs for NIF incorporate concrete and steel supports to increase the modal damping which lowers the overall response. Other concepts that incorporate visco elastic materials can increase system damping to even higher levels. Mirror mounts should be designed with a fundamental frequency above 50 Hz, which can be limited by space and mass constraints. Mirror mount enclosures should incorporate passively damped panels, which are inexpensive and significantly reduce acoustic coupling to the structure. Use of these guidelines should help achieve stability goals when designing similar systems.

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